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济阳坳陷沾化凹陷异常高压与油气成藏模式

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摘要:渤海湾盆地济阳坳陷沾化凹陷沙河街组二段及其以上层段, 圈闭类型以构造为主; 沙河街组三段及其以下地层, 主要发育岩性、构造-岩性等隐蔽圈闭。地层压力的分布与油气分布特征存在一定的对应关系, 即正常压力带发育构造油气藏, 而异常高压带多发育岩性等油气藏。异常高压为深层岩性油气藏油气的运移提供了动力。凡压力系数曲线呈现“3”字形, 则相对低压油层含油性较好。根据压力与油气成藏的关系, 建立了“源外断裂输导成藏”和“源内高压充注成藏”两种成藏模式。油源断层是浅部源外常压油气成藏的主控因素, 沙河街组三段中、下亚段及沙河街组一段生成的油气, 主要沿断层经垂向输导进入沙河街组二段及其以上地层, 直接在断块、滚动背斜等构造圈闭中充注成藏, 或经横向运移在构造圈闭中充注成藏。油气成藏动力是深部源内高压成藏的主控因素, 沙河街组三段中、下亚段生成的油气, 在异常高压的驱动下直接向其紧邻的砂岩体及构造-岩性圈闭中充注成藏。

关键词:异常高压; 圈闭; 油气成藏; 成藏模式; 沾化凹陷; 渤海湾盆地

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Abnormal pressure and hydrocarbon reservoiring pattern of the Zhanhua sag in Jiyang Depression

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Abstract: In Zhanhua sag of Jiyang Depression in Bohai Bay Basin, structural traps are predominant in the second member of the Shahejie Formation and the strata above it, while subtle traps such as lithologic and structural-lithologic traps dominate the third member of the Shahejie Formation and the strata below it. There is a certain correlation between formation pressure distribution and hydrocarbon distribution in the area, i. e., structural reservoirs occurring in areas with normal pressure while lithologic reservoirs being developed in areas with abnormal high pressure. Abnormal high pressure provides impetus for the migration of hydrocarbons in deep lithologic reservoirs. When the pressure coefficient curve presents a “3”-shape, reservoirs with relatively low-pressure have higher oil potentials. Based on the relationship between formation pressure and hydrocarbon accumulation, we set up two accumulation models: “external-sourced hydrocarbons accumulating via carrier faults” and “internal-sourced hydrocarbon accumulating via high-pressure injection”. Shallow external-sourced hydrocarbon accumulations with normal pressure are mainly controlled by source rock-rooted faults. For example, the hydrocarbon generated from the lower and mid parts of the third member of the Shahejie Formation migrates vertically along the faults and accumulates in the structural traps such as fault block and rolling anticlines in the second member of the Shahejie Formation and strata above it, or migrates laterally to and accumulates in structural traps. The controlling factor for the second pooling model is abnormal high pressure. Hydrocarbons generated from the lower and mid parts of the third member of the Shahejie Formation may be charged into adjacent sandbodies and structural-lithologic traps under the drive of the abnormal high pressure.

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充足及强活动断层的下降盘,而背斜-断层圈闭主要在邻近凸起部位的强活动断层下降盘发育^[3];岩性、构造-岩性圈闭的分布受岩体发育的制约,其中各物源沉积体系前端及深洼内部发育浊积岩性体圈闭,各物源沉积体前缘邻注断层下降盘发育断层-岩性圈闭,而强活动断层一侧扇体前缘发育岩性上倾尖灭圈闭^[4]。

3 油气藏与压力的关系

沾化凹陷地层压力与油气分布特征存在一定的对应关系,即目前发现的大部分油气分布在正常压力带构造油气藏中,而岩性等油气藏多分布在异常高压区之内^[5]。

沾化凹陷深部层系存在两期高压:第一次在东营末期出现,但构造抬升运动后减弱;第二期在馆陶后期至今^[6]。研究区第三系烃源岩供烃的成藏时期主要是在东营末期和新近纪晚期至今的两个时期^[7-13]。这两个时期在地质历史上都存在异常高压,说明异常高压为油气流体的运移提供了良好的动力条件^[14-19]。

不同的洼陷类型和不同的构造部位导致了不同的压力剖面形态,后者决定了能量场的空间叠置,这种叠置的形式又一定程度地决定了油气层产能的大小^[20-22]。沾化凹陷压力与油气分布关系的分析表

明,凡上覆地层呈现岩性与压力双重封堵,储集层与邻近层位存在压差,压力系数曲线呈现“3”字形(图2),则其下伏相对低压油层储量大、产量高。同时,距生油洼陷的距离也影响了日产量的高低。

4 油气成藏模式

沾化凹陷深部超压体系可以通过幕式排放向浅层输送油气。由于这种幕式排烃行为较常压稳流具有更高的能量,因此油气可以在剩余能量的驱动下进入常态下无法进入的圈闭内,为浅层油气成藏提供动力条件。并且,沾化凹陷油源断层的活动期次与烃源岩主排烃期相对应,从而为油气的垂向输导提供了条件^[23-26]。油源断层是浅部源外常压油气成藏的主控因素,成藏模式可概括为“源外断裂输导成藏”模式:沙三中、下亚段及沙一段生成的油气,主要沿断层经垂向输导进入沙二段及其以上地层,直接在断块、滚动背斜等构造圈闭中充注成藏,或经横向运移在构造圈闭中充注成藏。深部源内高压成藏体系油源条件优越、储-盖组合条件好,但是输导条件较差,油气成藏动力是圈闭成藏的主控因素,成藏模式可概括为“源内高压充注成藏”:沙三中、下亚段生成的油气,在异常高压的驱动下直接向其紧邻的砂岩体及构造-岩性圈闭中充注成藏(图3)。

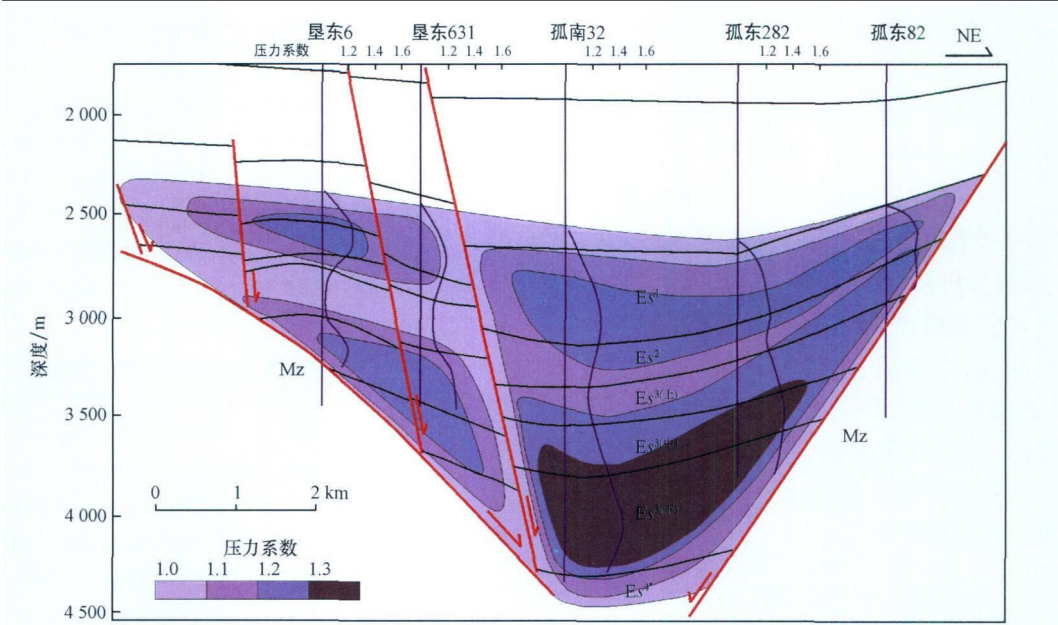


图 2 沾化凹陷地层压力分布剖面
Fig. 2 Profile of formation pressure distribution in the Zhanhua sag

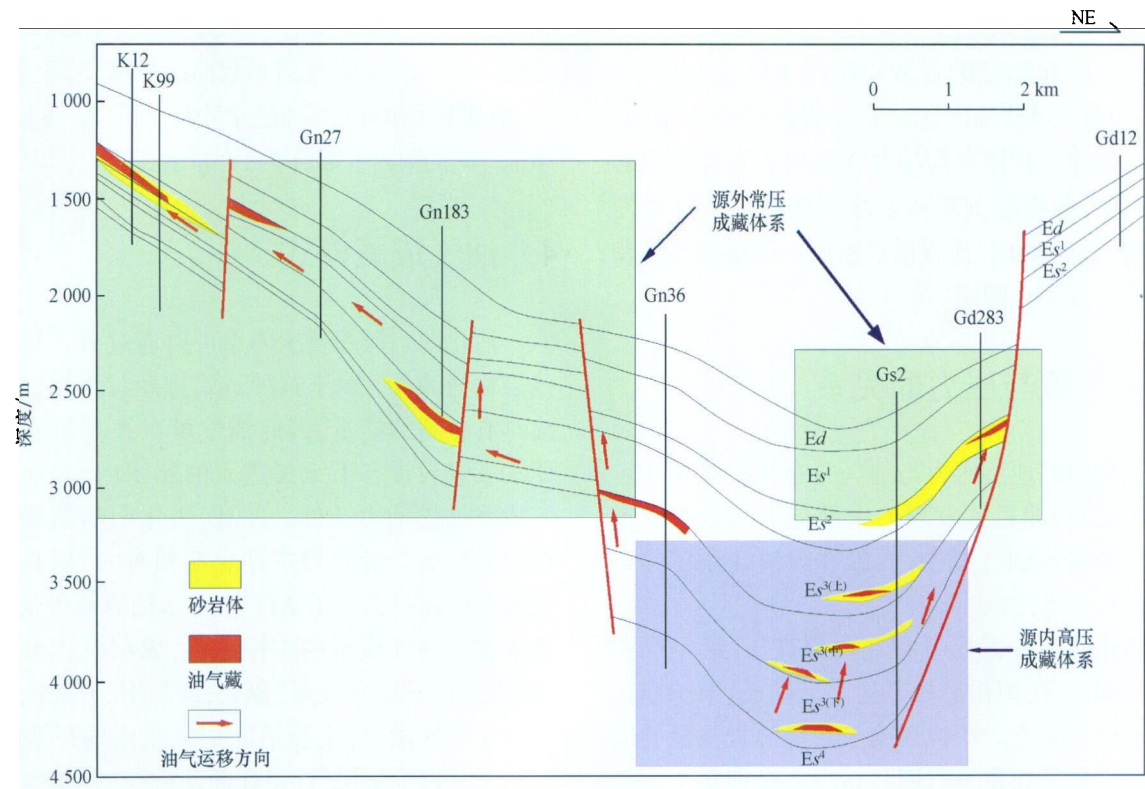


图3 沾化凹陷油气成藏模式

Fig. 3 Hydrocarbon accumulation models in the Zhanhua sag

5 结论

1) 沾化凹陷油气藏类型与异常高压的分布具有很好的耦合关系:正常压力沙二段发育构造油气藏,异常高压沙三段发育岩性、构造-岩性油气藏。

2) 沾化凹陷异常高压为油气的运移提供了动力来源,超压-常压-超压形成“3”字形压力曲线剖面,上、下高压层位的油气在压力的作用下向相对低压的储集层运移形成油气藏。

3) 通过分析沾化凹陷油气藏与压力的关系,建立了两种成藏模式:一是沙三中、下亚段及沙一段生成的油气,沿断层进入沙二段及其以上地层的“源外断裂输导成藏”模式;二是以沙三中、下亚段为油源的油气,在异常高压的驱动下直接向其紧邻的砂岩体及构造-岩性圈闭中充注成藏的“源内高压充注成藏”模式。

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(上接第605页)

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